

DIPLOCARDIA KANSENSIS, A NEW EARTHWORM FROM
KANSAS, WITH REDESCRIPTIONS OF
D. RIPARIA SMITH AND *D. FUSCULA* GATES
(ANNELIDA: OLIGOCHAETA: MEGASCOLECIDAE)

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Abstract.—The definition of *Diplocardia riparia* is changed to include an intestinal origin in the seventeenth segment. Consequently *D. prosenderis* is synonymized with *D. riparia*. *Diplocardia fuscula* is now understood to have genital markings in the male field and a variable circulatory system. *Diplocardia kansensis*, closely related to *D. riparia* and *D. fuscula*, is described from Kansas and Arkansas material. It is proposed to refer to the posterior extension of the extra-esophageal vessels of Megascolecidae as clitellar vessels, rather than as posterior latero-parietals.

Diplocardia riparia F. Smith was described from material collected in the floodplain of the Illinois River near Havana, Illinois. It has since been recorded from several locations around the American Midwest, from Ohio to Oklahoma and Nebraska (Olson 1928; Gates 1955, 1977; McNab & McKey-Fender 1955; Teotia et al. 1950). It is of minor economic importance in southern Kansas and western Missouri, where it is collected and sold for bait. There have been questions about the status of certain specimens (see Gates 1955). In the course of examining material identified by the late W. R. Murchie and deposited in the National Museum of Natural History (USNM), it became clear that the original description (F. Smith 1895a) and Eisen's (1899) additions contained information that was incorrect or misleading. Further, there were three distinct taxa represented in the USNM lots labelled *Diplocardia riparia*, one of which was clearly that species.

One lot labelled *D. riparia* actually belongs to *D. fuscula* Gates. In the course of examining these specimens and paratypes of *D. fuscula*, it was determined that the definition of *D. fuscula* needed to be altered.

Another group is similar to worms previously identified as *Diplocardia prosenderis*

McNab & McKey-Fender in James (1984, 1988) and James & Cunningham (1989). These worms are described here as *D. kansensis*. *Diplocardia prosenderis* was described as a subspecies of *D. riparia* (McNab & McKey-Fender 1955) and was elevated to specific rank in Gates (1977).

The species described below was determined to be new based on Gates (1977) and examination of *D. riparia* collected by F. Smith. A complete description of *D. riparia* is included to provide a single source for morphological characteristics of this species. No other museum collections were searched for representatives of this or any related species.

In placing these earthworms in subfamily Acanthodrilinae of the Megascolecidae, I follow the classification of Jamieson (1971) and Brinkhurst & Jamieson (1971).

Diplocardia kansensis, new species
Fig. 1A-C

Diplocardia prosenderis.—James, 1982:38.—
James, 1984:91.—James, 1988:479.—
James & Cunningham, 1989:79.

Material.—USNM 42137, limestone quarry east of Myron, Izard Co., Arkansas, 16 Apr 1962, W. R. Murchie; Konza Prairie

Research Natural Area, 1 km north of Interstate 70 in Geary Co., Kansas, 25 May 1981, S. W. James; West Kimball Road, Manhattan Riley Co., Kansas, 12 May 1986, S. W. James; Schoolyard at Browning and Dickens Sts., Manhattan, Riley Co., Kansas, 27 May 1987; upland tallgrass prairie in Fort Riley, Geary Co., Kansas, 16 Sep 1986, S. W. James; Big Basin, Clark Co., Kansas, 7 Oct 1986, S. W. James.

Description.—External characteristics: 55 to 100 by 2 to 3.5 mm, width at segment xxx, body cylindrical in cross section throughout, widest at segments vi to ix, segments 120 to 145. Setae closely paired throughout; setal formula AA:AB:BC:CD = 3:1:3.5:1.5. Prostomium tanylobous, peristomium smooth, biannulate segments iv plus one of iii or v, triannulate posterior to iv or v. Medium to dark brown anterior pigmentation, sometimes present along mid-dorsal line and on hindmost dorsal segments, nephridiopores near D. First dorsal pore 9/10 or 10/11, spermathecal pores on small bumps on leading edges of viii and ix, just lateral to setae a. Ovipores in xiv, presetal; male pores in xix in male grooves which are in AB in xviii to xx; prostatic pores and penial setae at ends of grooves. Clitellum 1/2 xii, xiii to xviii or xix, saddle-shaped to annular. Unpaired mid-ventral genital markings viii, ix or ix, x; rarely x, xi or all of viii to xi; unpaired mid-ventral genital markings xvii, xx; paired genital markings postsetal in xvii, xx (all), paired, postsetal in one or more of xx to xxii, pre-setal in some of xviii, xxi, xxii; some paired 20/21. Penial setae bowed, 750 to 850 μm by 12 to 17 μm , tips tapering to a point slightly flattened around the edges (Fig. 1C).

Internal characteristics: Septum 5/6 faintly muscled, 6/7 to 12/13 muscular, thickest in 7/8 to 9/10; last set of trans-septal muscles originating in xiii. Alimentary canal with gizzards in v, vi; esophagous smooth externally with some chloragogen, vascularized in xii to xiii, internal texture

pebbly changing to low longitudinal folds in xv, xvi; no calciferous lamellae. Small glands on dorsal and lateral surfaces of esophagus in vii–ix. Intestinal origin at 16/17 or within xvii, intestinal constriction usually present just anterior to origin of simple typhlosole in xxi or xxii; typhlosole half to one-third of lumen diameter.

Nephridia 2 per segment, stomate, without bladders, duct meeting body wall near D. Ascending tubule from nephrostome with blind “caecum.”

Vascular system with subintestinal trunk, single dorsal trunk, these connected by lateral trunks in v to ix, lateral-esophageal hearts in x to xiii. Lateral trunks have lateral and septal branches from a point above attachment to subintestinal trunk, in ix a large vessel from lateral trunk to body wall of segments ix to xii. Supra-esophageal vessel x to xiii, extra-esophageal v to xiii, in xiii branching out as clitellar vessel over xii to xvii. Small vessels from extra-esophageal to septa and body wall in v to xii.

Male sexual system holandric, testes and funnels free, coagulum usually filling x and xi; vasa deferentia from funnels under peritoneum, entering body wall in xvii; seminal vesicles of ix divided into 2 to 4 lobes, of xii divided into numerous small ovoid lobes, vesicles of xii larger. Paired prostates in xviii and xx, slender, 2 to 3 times longer than the delicate kinked ducts, extending through several segments.

Ovaries and funnels in xiii, free, ovaries fan-shaped or globular cluster of numerous strings. Spermathecae (Fig. 1B) in viii, ix, variable ampulla and diverticular shape. Diverticulum 4 to 5 lobed internally, or lobes slightly incised, sessile or ectal end free, diverticulum attached to duct below base of ovoid ampulla.

Holotype.—USNM 122285. Konza Prairie Research Natural Area, 1 km north of Interstate 70 in Geary Co., Kansas, 25 May 1981, S. W. James.

Paratypes (3).—USNM 122286. Konza

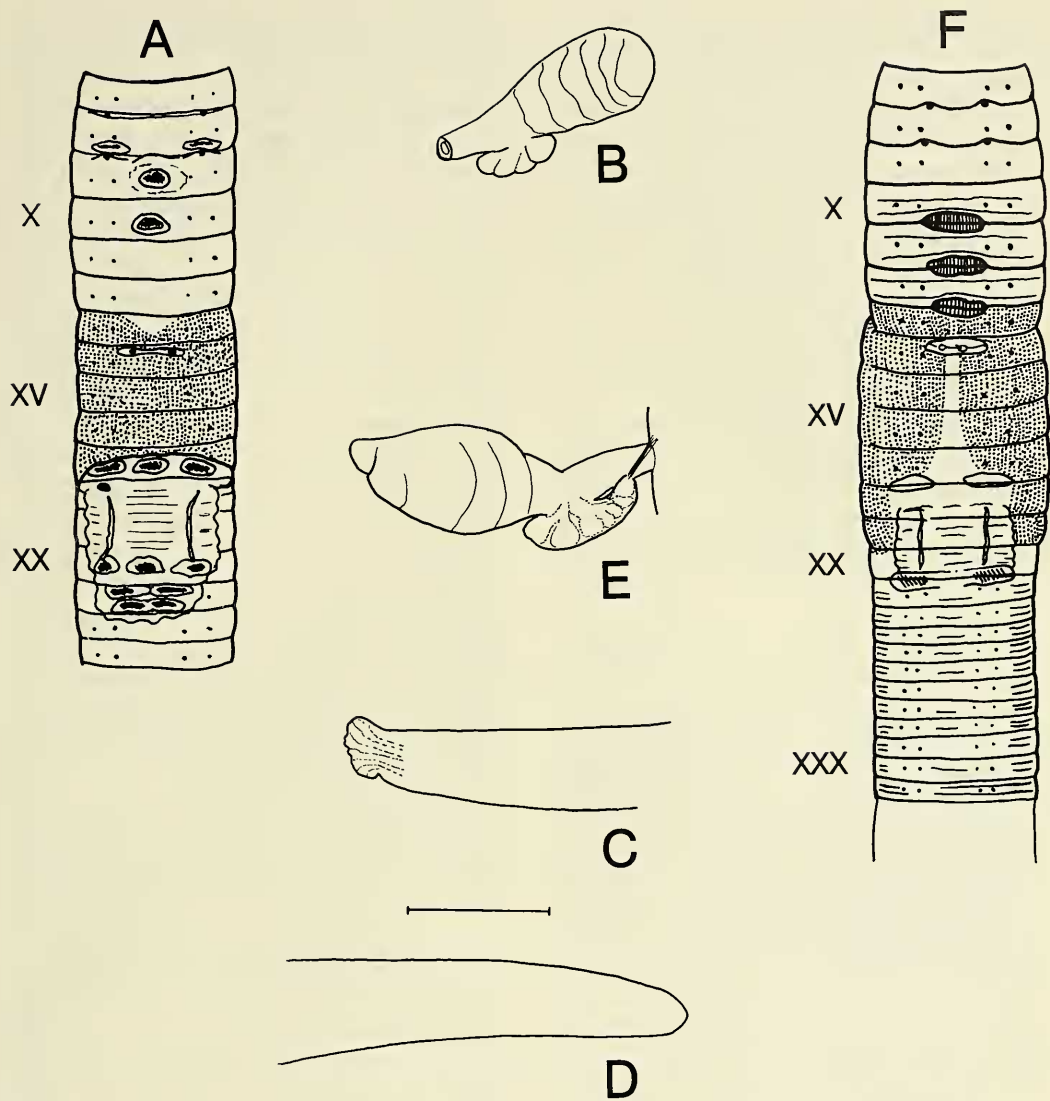


Fig. 1. *Diplocardia kansensis* new species: A, Ventral view of segments vii-xxiii; B, Spermatheca; C, Tip of penial seta, scale line equals 10 μ m. *D. riparia*: D, Tip of penial seta, same scale as C. *D. fuscula*: E, Spermatheca; F, Ventral view of segments vii to xxxi.

Prairie Research Natural Area watershed 1D, eroded waterway, 8 Oct 1988, S. W. James.

Remarks.—*Diplocardia kansensis* differs from *D. riparia* in the slightly spatulate tip of the penial setae, smaller body size, presence of pre-clitellar genital markings, the large number of genital markings, the pres-

ence of unpaired mid-ventral genital markings, greater typhlosolar development and a more anterior typhlosolar origin. This species can be distinguished from other members of the genus by the following set of characters: spermathecae in vii, ix; last hearts in xiii, no calciferous lamellae, genital markings pre- and post-clitellar, a typh-

losolar origin in or before xxii, and a tanylobous prostomium. In Gates (1977) or James (1990) it will key to *D. fuscata* Gates, from which it differs in size, disposition of clitellar markings, typhlosole, presence of clitellar vessels, and prostomium characteristics.

Diplocardia kansensis inhabits upland areas rather than river banks, though on Konza Prairie it is only abundant in eroded areas at the upper ends of water courses. However, none of the drainages along which it has been collected bear water except after heavy rains. The Big Basin material was obtained on prairie ridgetops under *Bison bison* dung pats. The nature of the habitat of Murchie's Arkansas material is unknown. James & Cunningham (1989) give the dietary habits of this species, under the name *D. prosenderis*.

Diplocardia riparia F. Smith, 1895

Fig. 1D

Diplocardia riparia.—Smith, 1895a:138.—Smith, 1895b:286.—Eisen, 1899:166.—Eisen, 1900:175, figs. 143, 144.—Michaelsen, 1900:325.—Smith, 1900:442.—Gates, 1955:242.—McNab & McKey-Fender, 1955:128.—Murchie, 1967:534. *Diplocardia riparia prosenderis*.—McNab & McKey-Fender, 1955:128.

Material.—Section 23, Range 18&19, Ohio Twp., Franklin Co., Kansas, in cattle feedlot near spring, 17 Apr 1987, S. W. James; bank of the Le Moine River near Ripley, Brown Co., Illinois, 6 Sep 1987, S. W. James; bank of the Chariton River near U.S. Hwy. 136, Schuyler Co., Missouri, 9 Apr 1988, S. W. James; bank of the Walnut River at fairgrounds, Winfield, Cowley Co., Kansas, 19 Sep 1987, S. W. James; bank of Cedar Creek, SW of Fairfield, Jefferson Co., Iowa, 11 Oct 1987, S. W. James; River Rat bait shop, Manhattan, Kansas (allegedly from SE Kansas), 16 May 1987; bank of Grand River, near Freeman, Cass Co., Missouri, 12 Jun 1987, S. W. James; Minnesota Bait and Fly shop, Kansas City, Kansas, 12

Jun 1987; Angler's Market, Harrisonville, Missouri, 12 Jun 1987; bank of Stranger Creek at Kansas Hwy 92, Leavenworth Co., Kansas, 22 Jun 1987, S. W. James; USNM 42142, Newlight, Tensas Parish, Louisiana, 16 Apr 1966, R. E. Tandy; USNM 42139, Illinois Hwy 149 W of Murphysboro, Jackson Co., Illinois, 19 Apr 1963, W. R. Murchie; USNM 42143, Beaucoup Creek, N of Murphysboro, Jackson Co., Illinois, 11 Apr 1967, W. R. Murchie; USNM 42144, Prairie Creek, Benton Co., Iowa, 15 Apr 1963, W. R. Murchie; USNM 42145, Osage Fork at Rt. 5, Laclede Co., Missouri, 18 Apr 1963, W. R. Murchie; USNM 26409, Dirty Creek Bottoms, near Warner, Oklahoma, Apr 1954, V. L. Rounds; USNM 47995, Kansas, "various localities," Nov 1917, Mr. Harrah (F. Smith collection); USNM 48035, Havana, Mason Co., Illinois, 24 May 1894, F. Smith; USNM 47993, Havana, Mason Co., Illinois, Apr 1895, F. Smith; USNM 47994, bottomlands near Rankin Crossing Bridge, White Heath, Piatt Co., Illinois, 10 Apr 1915, F. Smith. Types lost.

Description.—External characteristics: 85 to 170 by 4 to 6 mm, width at segment xxx, body cylindrical in cross section throughout, widest at segments vi to ix, segments 126 to 206. Setae closely paired throughout; setal formula AA:AB:BC:CD = 3:1:4:1.4. Prostomium tanylobous, numerous longitudinal furrows in peristomium, biannulate iii or v, triannulate posterior to iv or v. Medium to dark brown segments iv plus one of anterior dorsal pigmentation, sometimes present along mid-dorsal line and on hindmost segments, nephridiopores near D. First dorsal pore 9/10 to 12/13, spermathecal pores on small bumps on leading edges of viii and ix, just lateral to setae A. Ovipores in xiv, presetal; male pores in xix in male grooves which are in AB in xviii to xx; prostatic pores and penial setae at ends of grooves. Clitellum xii to xviii or xix, saddle-shaped or interrupted at mid-ventral line, paired genital markings postsetal in xvii (all), paired, postsetal in one or both of xx—

xxi. Penial setae bowed, 700 to 900 μm by 22 to 28 μm , tips tapering to a conical, unsculptured point (Fig. 1).

Internal characteristics: Septa 5/6 to 12/13 muscular, thickest in 7/8 to 9/10; last set of trans-septal muscles originating in xiii. Alimentary canal with gizzards in v and vi, esophagous smooth externally with some chloragogen, vascularized in xi to xiii, internal texture pebbly changing to low longitudinal folds by xv, xvi; no calciferous lamellae. Intestinal origin at 16/17 or within xvii, intestinal constriction usually present just anterior to origin of simple low to rudimentary typhlosole in xxii to xxv.

Nephridia 2 per segment, stomate, without bladders, duct meeting body wall near D.

Vascular system with subintestinal trunk, single dorsal trunk, these connected by lateral trunks in v to ix, lateral-esophageal hearts in x to xiii. Lateral trunks have lateral and septal branches from a point above attachment to subintestinal trunk, in ix a large vessel from lateral trunk to body wall of segments ix to xii. Supra-esophageal vessel ix or 9/10 to xiii, extra-esophageal iii to xiii, in xiii branching out to body wall over xii to xvi. Small vessels from extra-esophageal to septa and body wall in v to ix.

Male sexual system holandric, testes and funnels free, coagulum usually filling x and xi; vasa deferentia from funnels, under peritoneum, entering body wall in xvii. Seminal vesicles of ix divided into two or three lobes, of xii divided into numerous small ovoid lobes; vesicles of xii larger. Paired prostates in xviii and xx, long and slender, several times longer than the kinked ducts, extending through several segments. Stout ducts lacking muscular sheen, meeting body wall just posterior to penial setal follicles.

Ovaries and funnels in xiii, free, ovaries fan-shaped or globular cluster of numerous strings. Spermathecae in viii, ix, variable ampulla and diverticular shape. Diverticulum 3 to 6 lobed internally, slightly incised, ental end sessile, ectal end free, di-

verticulum attached to thickened portion of duct below base of ampulla.

Remarks.—Types of *D. riparia* are not mentioned in Reynolds & Cook (1976:163).

The most important difference between the material examined here and earlier descriptions is the intestinal origin in xvii, rather than xviii. It was repeatedly observed that relaxed specimens and those that had been starved prior to preservation appeared to have an intestinal origin posteriorly in xvii or apparently in xviii. Specimens fixed with full guts, as were all of Murchie's and mine, clearly showed an intestinal origin within xvii or at 16/17, which is commonly interpreted as in xvii. Sections made by F. Smith and now at USNM have collapsed intestines, the first segments of which have longitudinal furrows resembling the valvular condition of the last portions of the esophagus.

McNab & McKey-Fender (1955) used the segment of intestinal origin and spermathecal characters to define *Diplocardia riparia prosenderis*, but spermathecal variation within individuals and within populations is equal to that deemed of subspecific rank. This is not to say that consistent geographic variations in spermathecal details do not exist. However, the consistency of somatic morphology within the material examined argues against naming subspecific variants.

Since *D. riparia prosenderis* McNab & McKey-Fender was distinguished from *D. riparia* primarily on the basis of an intestinal origin in xvii, I suggest that this subspecies, elevated to specific rank by Gates (1977), be synonymized with *D. riparia*. *Diplocardia riparia prosenderis* is also unrepresented by types.

Diplocardia fuscula Gates 1968

Fig. 1E, F

Diplocardia fuscula. —Gates, 1968:22.—Gates, 1977:21.

Material.—USNM 42134, Greenwood, Caddo Parish, Louisiana, 16 Nov 1954, D.

Brumfield coll. USNM 38789, Negreet, Sabine Parish, Louisiana, 28 Mar 1965, R. E. Tandy, G. E. Gates, and J. M. Byrd, coll. (paratypes).

Description (Greenwood material).—External characteristics: 154 to 193 by 5 to 7 mm, width at segment xxx, body cylindrical in cross section throughout, widest at segments vi to ix, segments 120 to 145. Setae closely paired throughout; setal formula AA: AB:BC:CD = 4:1:5:2. Prostomium proepilobous, peristomium furrowed, segments biannulate iii, iv or iv only, triannulate posterior to iv. Traces of medium brown anterior dorsal pigmentation (bleached by preservative?), sometimes present along mid-dorsal line and on posterior segments, nephridiopores near D. First dorsal pore 10/11, spermathecal pores on small bumps on leading edges of viii and ix, just in the line of or median to setae a. Ovipores in xiv, presetal; male pores in xix in male grooves which are in AB in xviii to xx; prostatic pores at ends of grooves. Clitellum 1/2 xii, xiii to xix, interrupted at mid-ventral line. Unpaired mid-ventral sucker-like genital markings 10/11, 11/12, 12/13; paired genital markings postsetal in xvii (all), sometimes in xx (Fig. 1). Penial setae vestigial, sigmoid, not markedly different from ambulatory setae.

Internal characteristics: Septum 5/6 faintly muscled, 6/7 to 12/13 muscular, thickest in 7/8 to 9/10; last set of trans-septal muscles originating in xiii or xiv. Alimentary canal with gizzards in v, vi; esophageous smooth externally, covered with brown chloragogen, vascularized in xii to xv, internal texture pebbly changing to low longitudinal folds by xv, xvi; ventral esophageal typhlosole viii to xiv; no calciferous lamellae. Intestinal origin in xviii, intestinal constriction anterior to origin of simple typhlosole in xxiv or xxv; typhlosole one quarter of lumen diameter or less.

Nephridia 2 per segment, stomate, without bladders, duct meeting body wall near

D. Ascending tubule from nephrostome with blind "caecum" at point of joining with main nephridial tubule.

Vascular system with subintestinal trunk, single dorsal trunk, these connected by lateral trunks in v to ix, lateral-esophageal hearts in x to xiii. Segmental vessels of xiv to xvi not connected to ventral trunk; posterior latero-parietal vessels lacking. Lateral trunks of vi to viii have body wall and septal branches from a point above attachment to subintestinal trunk, of v, vi with body wall branches and vessels to gizzard; in ix a large vessel from lateral trunk to body wall of segments ix to xii. Supra-esophageal vessel x to xiii, extra-esophageal v to xii, originating as small sub-pharyngeal vessels in i or ii. Small vessels from extra-esophageal to septa and body wall in vi to xii, to gizzards in v, vi.

Male sexual system holandric, testes and funnels free, coagulum usually filling x and xi; vasa deferentia from funnels superficial, passing lateral to prostatic ducts, entering body wall at 18/19; seminal vesicles of ix divided into 2 to 4 lobes, of xii divided into numerous small ovoid lobes, vesicles of xii larger. Paired prostates in xviii and xx, slender, 2 to 5× longer than stout, muscular ducts, glands in segments of origin or also extending into one or two adjacent segments; duct diameter increasing ectally.

Ovaries and funnels in xiii, free, ovaries fan-shaped or globular cluster of numerous strings. Spermathecae (Fig. 1E) in viii, ix, ovoid ampulla, variable diverticular shape. Diverticula 1 to 5 lobed internally, attached at middle by a short, broad stalk to lateral or anterior face of spermathecal duct, a muscle attaching ectal diverticular end to base of the preceding septum.

Remarks.—These worms were identified as *Diplocardia riparia* by W. R. Murchie, probably on the basis of pigmentation and intestinal origin. Since *D. riparia* is now understood to have an intestinal origin in xvii, placing these specimens in *D. riparia*

is inappropriate. There are other differences, such as the locations of genital markings and the size of penial setae.

One specimen of *D. fuscula* reported by Gates (1968) has the same location and date as the material described herein, but the collector is (erroneously?) listed as "D. Brumble." No mention was made of variation that may be related to location of collection, and the holotype was chosen from the Negreet specimens. Differences between the Greenwood specimens and the paratypes are (characteristics of the former are given): an intestinal origin in xviii, extra-esophageal trunks not extending to xiv and, segmental vessels of xiv to xvi not meeting the ventral trunk. However, the three paratypes were variable in several characteristics, and two disagreed with the description given by Gates (1968): These two have posterior latero-parietal trunks in xiii and supra-esophageal vessels terminating in xiii. The third lacks posterior latero-parietals and its supra-esophageal vessel ended in xiv, and agrees with the species description in these and most other particulars. However it has post-clitellar genital markings, a characteristic shared with the other paratypes, but not with Gates' description.

The great majority of characteristics usually considered of systematic importance in this genus are similar in the Greenwood and Negreet lots. The major difference—and in view of the vascular system variability in the *D. fuscula* paratypes—the only consistent difference, is the segment of intestinal origin. The collection locations are approximately 100 km apart and in separate river drainages. The two lots may be considered subspecifically distinct, but until more data can be collected on geographic variation in *D. fuscula*, they should be considered the same variable species.

In view of the change in the definition of *D. riparia* proposed above, and the new data on *D. fuscula*, *D. fuscula* is now to be distinguished from *D. riparia* by reduction or

loss of penial setae, frequent replacement of posterior latero-parietal vessels with large segmental connections from the dorsal vessel to the body wall and the ventral vessel, presence of unpaired pre-clitellar genital markings and a greater number of segments. Contrary to the original description, *D. fuscula* are not characterized by lack of genital markings in segments xvii and xx, and variability in intestinal origin and the blood circulation in clitellar segments are to be expected.

For the sake of clarity in future discussions of the vascular system in megascolecids, I propose to replace the cumbersome term "posterior latero-parietal vessel" with "clitellar vessel." This pair of vessels is the posterior extension of the extra-esophageal vessels. The posterior extent of branches of the clitellar vessel coincides closely with the termination of the clitellum. In the Puerto Rican *Trigaster longissimus* (Borges & Moreno 1990), the clitellum begins in xx and the clitellar vessel in xviii. This clearly indicates a functional connection between external and internal characteristics, and nomenclature should reflect this.

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